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The potential for reservoir fisheries and aquaculture in Eastern Province, Zambia

Mara Gellner, Jonas W. Ng'ambi, Stefan Holler, Alexander M. Kaminski

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Abstract

This report provides the background, methodology and findings of a scoping study on dam-based fisheries and small-scale fish farming and consumption in the Eastern Province of Zambia. The aim of the study was to increase understanding of the current situation and the potential for improving sustainable fisheries and aquaculture for greater food and nutrition security. This report focuses mostly on dam-based fisheries (capture and culture) and small-scale fish farming in six districts in the province: Chipata, Petauke, Lundazi, Katete, Sinda and Mambwe. The focus was on understanding of the current aquaculture and fisheries landscape and on the potential development pathways of increasing fish production, including for improved incomes and food and nutrition security. A focus on fish trading and consumption was therefore a key priority. Information was collected through key informant interviews with stakeholders and semi-structured interviews with fish farmers, fish traders and consumers. Focus group discussions with fish farmer cooperatives and dam management committees complemented the database. Fish production has high potential in the Eastern Province due to several reasons: there are many small water bodies (SWB) in the region and currently fish farming is entirely in the hands of small-scale farmers due to the absence of commercial aquaculture actors. Fish is an important source of food: small-scale producers consume the fish they produce in their family or market the fish within their own village locally. The report concludes with recommendations for development actors who are keen to engage in fish production in the province.

Keywords

Dam-based fisheries, aquaculture, small-scale farmers, food and nutrition security, Zambia

Executive summary

The Seminar für Ländliche Entwicklung (SLE – Centre for Rural Development) of the Humboldt-Universitaet zu Berlin in Germany embarked on a research project entitled "Opportunities and challenges for small-scale fish farmers in Zambia" from August to October 2018. The project was commissioned by the Advisory Service on Agricultural Research for Development (BEAF), a unit within the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. The aim of the research was to assess the role of fish farming within the livelihoods of smallholder fish farmers in Zambia. The main report generated by this research primarily focuses on the Northern, Lusaka and Southern Provinces of Zambia, however there was interest from the GIZ "ONE WORLD - No Hunger" (SEWOH) programme operating in Zambia in assessing the potential of small-scale fish farming and fisheries in Eastern Province as well. The present report is therefore an additional, complementary study to the main research and focuses on the potential of fish production in Eastern Province, Zambia. The major findings were as follows:

- Fish production is scarce in the province due to there being relatively few perennial natural water sources compared to other parts of Zambia. The province is partly located in the Luangwa valley, where temperatures are higher and rainfall lower than other regions in Zambia.
- Aquaculture is not a large part of agricultural and economic activities in Eastern Province in Zambia, and the province has some of the lowest numbers of registered fish farmers in the country.
- Fish consumption seems to be generally quite low in the province as compared to other areas, mainly due to a lack of large capture fisheries and aquaculture, although there is a major fish trade corridor between Zambia and Malawi going through Chipata where fish from Lake Malawi is available. The most commonly consumed fish species are tilapia (63.5 %), followed by kapenta (various freshwater sardine species) (23.1 %).
- Fish farming is a secondary activity that produces fish mostly for home consumption. Most of the farmers cultivate agricultural crops and are involved in livestock rearing as their main source of income.
- There are five government aquaculture stations in the area (Chipata, Lundazi, Katete, Nyanje and Chadiza), which are intended to be aquaculture demonstration and research centres and sources of fingerlings. Chipata operates as the central hatchery providing broodstock to Lundazi, Katete, Nyanje and Chadiza fish farms, which are more closely located to rural farmers. Three stations (Lundazi, Katete, Chadiza) have completely ceased production of fingerlings, and the remaining two active ones are only partly functional, mainly due to limited funding over a number of years. Government aquaculture facilities in the province are in need of urgent rehabilitation.
- The greatest potential for aquaculture in Eastern Province lies in the numerous small water bodies (SWBs) that operate as small irrigation dams. These SWBs have a vast capacity for cage

or pen culture of fish. In some instances these SWBs act as culture-based fisheries where they have been stocked with fish, either artificially by the government or naturally through connecting water bodies (seasonal streams).

- Dam management committee members confirmed that most of the caught fish is for home consumption or sold within the villages. Moreover, the dams help to improve accessibility to fish for consumption. Site visits during the research confirmed that women and children have access to this resource and catch small quantities of various fish species with lines and hooks for direct home consumption.
- Low-lying valley areas with a perennial water supply can provide an alternative location for clusters of fish farmers, although management challenges associated with undrainable ponds and seasonality may need to be taken into consideration.
- Challenges to fish farming in the region include a lack of development incentives and inadequate technology transfer to fish farmers, since most NGOs in the area have concentrated their support on agricultural activities.
- The ready market for fresh and dried fish and the visible absence of commercial fish farming in the area create a huge opportunity for small-scale producers.

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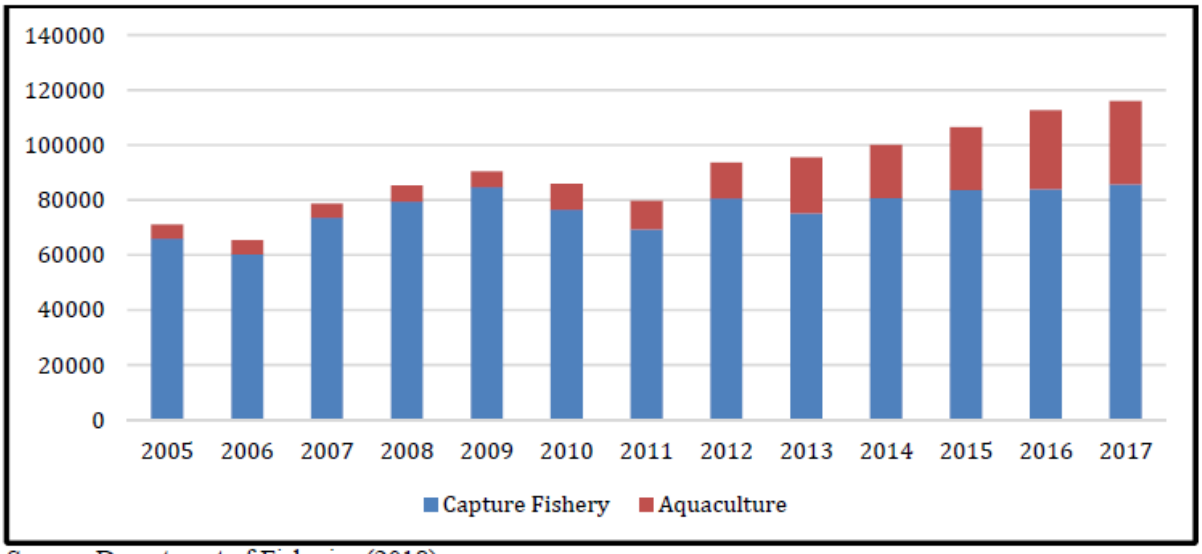
Abbreviations

ALCOM	Aquaculture for Local Community Development Programme
DO	Dissolved oxygen
DoF	Department of Fisheries
BEAF	Advisory Service on Agricultural Research for Development
ESAPP	Enhanced Smallholder Agriculture Promotion Programme
FCR	Food conversion ratio
FIES	Food insecurity experience scale
GDP	Gross domestic product
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
IFAD	International Fund for Agricultural Development
mt	Metric tonne
NGO	Non-governmental organisations
SEWOH	"One World – No Hunger" initiative
SLE	Centre for Rural Development
SUN	Scaling Up Nutrition programme
SWB	Small water body
USADF	United States African Development Foundation
ZMK	Zambian kwacha

1 Background of fish production

Fish is a regular part of the Zambian diet and contributes over 20 % of animal protein in people's diets (Musumali et al. 2009, NFDS Africa 2016). Fish plays a significant role in dietary diversity and nutritional security, especially for poorer households in urban and rural areas alike (Mofya-Mukuka and Kabisa 2017, Genschick et al. 2018). Zambia's total fish demand is estimated to be 185,000 mt per annum (African Development Bank 2016), while in 2017 total fish production was estimated to be 120,963 mt, of which 32,888 mt was from aquaculture production, representing almost one third of total fish production (DoF 2018). Additionally, a further 37 % of the national fish requirement is met through imports from various countries.

Fish catches from Zambian lakes and rivers have stagnated at around 80,000 mt p. a., despite increased fishing efforts (DoF 2018) (Figure 1). Fish stocks of commonly consumed species such as "kapenta" – a name for different, pelagic small freshwater fish species (*e.g. Engraulicypris Engraulicyprisardella*, *Limnothrissa miodon)* – are exploited to their maximum and a further increase in the supply of fish from wild catches seems unlikely. To fulfil the demand for high value fish protein for Zambia's growing population, aquaculture is becoming an increasingly important livelihood strategy and a contributor to gross domestic product (GDP) (Kruijssen et al. 2018).



Source: Department of Fisheries (2018).

Figure 1: Annual fish production in Zambia from capture fisheries and aquaculture (mt)

Aquaculture in Zambia grew considerably between 2005 and 2017. Kaminski et al. (2018) show that aquaculture almost tripled between 2004 and 2014, mostly due to the introduction of large-scale cage culture and land-based pond companies in the south of the country. The aquaculture value chain has become increasingly commercialised and has been upgraded with high quality feed and seeds that has

recently become available in the country (Kaminski et al. 2018; Kruijssen et al. 2018). The growth of the small-scale sector has not kept pace with this trend, mostly due to challenges in accessing inputs, training and other services. While many of these farmers grow fish as a semi-commercial activity, mainly for consumption at home and by rural populations nearby, productivity and total production are thought to be low (Kruijssen et al. 2018).

The conditions for fish farming in Zambia are diverse and vary between regions. In Eastern Province, fish are scarce due to there being relatively few perennial streams and lakes compared to other areas in Zambia, therefore aquaculture mostly depends on water being diverted from reservoirs or seasonal production of fish in rain-fed wetlands. This means that the number of sites suitable for pond culture is likely to be limited, although this was not fully explored in the present study. Estimates by the Department of Fisheries (DoF) (2015) indicate that approximately 1,500 small-scale fish farmers operate in Eastern Province, mainly cultivating three-spotted tilapia (*Oreochromis andersonii*). This is an important indigenous fish for Zambia as it is undergoing a national genetic improvement programme. The present study aimed to establish the number of active fish farmers in Eastern Province and to learn more about their current cultivation methods and challenges.

In order to meet the high demand for fish, the Department of Fisheries established four government-run hatcheries in Eastern Province. The main hatchery is the central Chipata Aquaculture Research Station where the primary broodstock is kept, while the other four government-run fish farms, located in Sinda (Nyanje), Lundazi, Katete and Chadiza, act as decentralised fingerling production units. At present, there are no private hatcheries operating in the province. One aspect of this study was to gather information about the capacity and function of these hatchery units and their efficiency at distributing seeds.

A considerable number of reservoirs (called small water bodies (SWB) or dams) have also been established in Eastern Province for irrigation purposes and to supply water for livestock and household use. These dams also act as culture-based fisheries whereby SWBs are artificially stocked by (government-run) hatcheries and managed by community-run dam management committees like a capture fishery (*i.e.* no feeding regimes). These systems also have the potential to contribute nutritious fish to the daily diet of resource-poor people, especially women and children (ALCOM 1997). This study investigated the current management of these systems and their potential for food and nutrition security.

2 Objectives and methods

The two-week field trip (19 August – 2 September 2018) was conducted in the Chipata, Petauke, Lundazi, Katete, Sinda and Mambwe districts in Eastern Province (see Fig. 2). These districts were selected because they are the most productive areas for fish farming in the province, according to the provincial fisheries officers in the DoF.

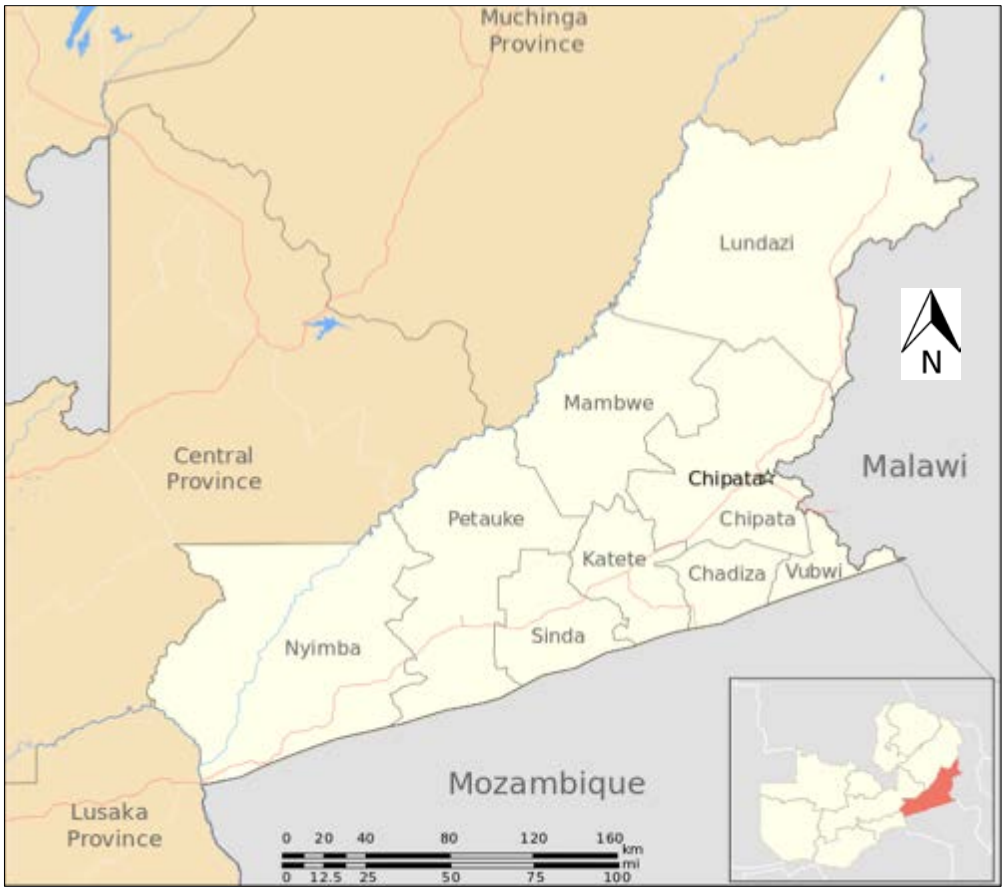


Figure 2: Study area in Eastern Province : Chipata, Lundazi, Petauke, Katete, Sinda and Mambwe districts

The objectives of the scoping study were:

- to evaluate the current status and potential of government-run hatcheries and provide recommendations on improving fingerling productivity and distribution
- to assess aquaculture production systems in the province and identify opportunities and challenges, including cage farming and/or culture-based fisheries in dams and reservoirs
- to assess the productivity, function and management of reservoirs (small water bodies and dams), with a special focus on the contribution to food security, especially for women and children
- to assess potential conflicts with other forms of water use (drinking water, water for agricultural use *etc*.)
- to explore current management regimes of small water bodies and dams
- to analyse the source, availability and affordability of fish and fish preferences in the diets of rural and urban Zambians

- to explore current feeding strategies with farmers and identify opportunities for integration with other value chains or on-farm activities.

A total of 57 consumers were interviewed (15 women, 42 men) from five different categories (see Table 1): fish farmers (13), urban dwellers (13), fish traders (7), rural dwellers with access to SWBs and/or ponds (20), and rural individuals without access to SWBs and/or ponds (4).

Table 1: Consumer survey

	Fish farmers	Urban dwellers	Fish traders	Rural dwellers with pond	Rural dwellers without pond
Total	13	13	7	20	4
Men	12	7	4	17	2
Women	1	6	3	3	2

Questionnaires were conducted using the Food Insecurity Experience Scale (FIES). The FIES is an index of access to food at individual or household levels. It measures the severity of food insecurity based on people's responses to questions about constraints on their ability to obtain adequate food. The FIES is derived from two widely used experience-based food security scales: the *US Household Food Security Survey Module* and the *Latin American and Caribbean Food Security Scale*. It consists of a set of eight short "yes" or "no" questions asked directly in face-to-face interviews. The questions focus on self-reported, food-related behaviours and experiences associated with increasing difficulties in accessing food due to resource constraints. The FIES is based on a well-grounded construct of the experience of food insecurity and comprises three domains: uncertainty/anxiety, changes in food quality and changes in food quantity (Ballard et al. 2013). The answers result in four different scales: "food secure", "mildly food insecure", "moderately food insecure" and "severely food insecure".

The second part of the questionnaire was about the frequency of fish consumption, sources of fish, and the species, amount and price of the last fish purchased. The answer categories for the frequency of fish consumption were "daily", "weekly", "monthly", "yearly" and "never". The answer categories for the most common source of fish are "from the lake", "from the fish farm pond", "from the local market", "from the supermarket" and "from another place". Participants were asked more specifically about the last fish they purchased for the household and answered with the fish species they bought/caught, how much it weighed (grams) and the value of the fish (in Zambian Kwacha - ZMW). The information on the frequency of fish consumption, the number of household members and the weight of the last fish bought allowed the average consumption of fish in kg/person/year to be calculated. The prices (ZMW/kg) of the different fish species were calculated using the numbers given for the last fish species purchased.

Seven key informant interviews with provincial and district fisheries officers and hatchery managers were also conducted. In Lundazi, the team interviewed the manager of the only private fish hatchery in Eastern Province, which is still under construction. Semi-structured interviews where held with 13 small-scale fish farmers (12 men, 1 woman). Focus group discussions (with about 20 people) were conducted

with two fish farmer cooperatives: one in Chipata with 48 members and another small-scale farmer's cooperative in Lundazi with over 80 members. Three dam management committees were also interviewed.

The interview guidelines for the key informant interviews with hatchery managers are provided in Annex 4. Semi-structured interviews with fish farmers, consumers and fish traders were conducted according to the digital questionnaires "Consumer2018MW", "Supplychainactor2018MW" and "Fishfarmer2018MW" provided by GIZ. Focus group discussions and key informant interviews with the dam management committees were conducted in accordance with a template provided by GIZ. A detailed description of the objectives and methods is presented in Annex 1. Annex 2 provides the list of stakeholders and key informants, and Annex 3 contains the travel schedule.

3 Results and discussion

3.1 Physical and climatological characteristics of the area

Eastern Province has great potential for agriculture due to favourable conditions for the growth of many crops such as tobacco, groundnuts, sunflowers, soybeans, wheat, sweet potatoes and cotton, and for livestock production of cattle, goats and poultry for example. The province, which is lightly hilly with wide shallow valleys of gentle slopes and an open savanna biome, has been described as a marginal area for fish farming. The average annual rainfall is limited to 1,014 mm and is concentrated between November and April. Evaporation is on average 1,448 mm, leading to a rainfall deficit of 434 mm (Goppers and Miller 1989). Few perennial streams exist, which is a reflection of the mostly coarse-textured soils with a low to moderate water retention capacity. Waters in the area have been described as slightly acidic and of low fertility (ALCOM 1988). This could change over a long period of time and may vary from one area to another. A water availability analysis is required when considering any serious aquaculture investment, and some capital investments (pumps, boreholes) may also be required.

In the district of Chipata there are hardly any perennial streams. It is estimated that 99 % of streams run dry by the end of August (ALCOM 1988). The number of sites suitable for pond fish culture is limited and the only potential alternative sites are small water bodies. Temperatures average a high of 27.7 °C and a low of 16.3 °C minimum. Normal tilapia reproduction is limited to the warmer months from September to March, when average temperatures exceed 22 °C. Given these physical and climatological aspects, the area calls for a cautious approach to fish farming development (Goppers and Miller 1989).

3.2 Fish farming statistics

According to the DOF's fisheries statistics annual report of 2014, Eastern Province had a total of 1,533 farmers producing an estimated 134.46 mt of fish. During the present study, statistical information from key informants showed that out of a total of about 1,965 registered farmers in the area, only 719 were actively involved in fish farming. This means that 67 % of registered fish farmers in the province are

currently inactive. Evidence from this research suggested that a large number of farmers have abandoned production. Although the reasons for this were not explicitly explored, it became obvious that water shortages and a lack of inputs prevented farmers from successfully growing fish. Further investigation would be required to reveal all the challenges they faced.

This study showed that most fish farmers depend on seasonal rain-fed excavated ponds located in shallow valleys with gentle slopes. These areas seem to have clayey soils that hold water when other surrounding areas dry up. Many of these fishponds, however, still dry up between July and August with the onset of summer. It was therefore difficult to generate reliable statistics and observations because many farmers had no water in their ponds or were not fish farming at that time. Key informant interviews with the DoF revealed that the department faces many challenges in visiting farmers and providing extension support. It was therefore difficult to estimate the total number of active farmers at a given time because it also appeared to vary between seasons. Production or total yield data were even more difficult to estimate because most surveyed farmers produced fish for subsistence, meaning that households have partial harvesting strategies throughout the year for household consumption. None of the surveyed farmers kept records on pond size, stocking densities or other key variables required to measure productivity. It was also very difficult to extract their existing knowledge about this. Table 2 gives the recent fisheries and fish farming statistics provided by the key informants, DoF officers, during this study compared to the numbers in older registers from the district reports.

Table 2: Statistics on fish farming and small water bodies

District	Pond culture		Small water bodies	
	No. of registered fish farmers	No. of active fish farmers	No. of SWBs	No. of SWBs stocked with fish
Chipata	223	54	22	10
Katete	50	25	10	2
Sinda	205	167	5	0
Petauke	50	25	36	2
Lundazi	1,427	438	33	2
Mambwe	10	10	2	0
Total	1,965	719	108	16

SWBs in Zambia are concentrated in the Eastern and Southern Provinces, which are more prone to drought than other parts of the country (Fig. 3). Most of these reservoirs were built in the 1950s and 1960s to mitigate drought conditions and provide water for livestock and irrigation.

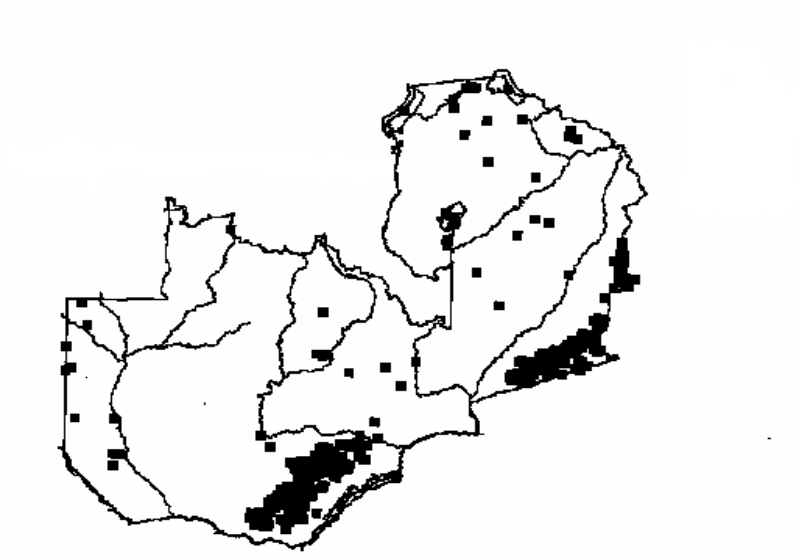


Figure 3: Location of small water bodies in Zambia (Mudenda 2009)

There is conflicting information about the actual number of small water bodies in Eastern Province. An earlier study by Goppers and Miller (1989) reported 213 SWBs covering an area of 2,000 ha. A more recent report suggests 135 SWBs covering an area of 675 ha (Musuka & Musonda 2013). It could be that, since 1989, many of these dams have either dried up or are no longer managed, although this needs to be explored further. The DoF (2014) fisheries statistics annual report mentioned 125 active SWBs covering an area of 625 ha. During the present study, a key informant from the DoF confirmed that there are about 140 SWBs in the province, some of which are not currently active. In recent decades some of these water bodies have been artificially stocked with fish to provide a source of protein to surrounding communities, while other dams have been naturally stocked with fish from connecting water bodies (seasonal streams).

3.3 Fingerling supply and availability

The main fish species cultured in Eastern Province are *Oreochromis andersonii, Oreochromis macrochir, Tilapia rendalli* and *Clarias gariepinus*. Some reports from farmers suggested that *Oreochromis niloticus* still exists in some systems and water bodies in Eastern Province, although this could not be verified. It was suggested that this species was introduced decades ago by donor-driven programmes before any regulations on species restrictions were in place. While *O. niloticus* is used in the south of the country with special permits, the government has banned its use elsewhere nationally, including Eastern Province, due to concerns around local fish biodiversity and the effects of introducing non-native fish species to the environment (Genschick et al. 2017). As an alternative, *O. andersonii* has been identified as an indigenous fish species suitable for improving aquaculture in Zambia (Gopalakrishnan 1988, Kefi et al. 2013) and is thus promoted in Eastern Province.

Eastern Province has four government fish farms at Lundazi, Chipata, Nyanje and Chadiza, with a total of 49 fishponds covering a total area of 7.8 ha (Mudenda 2009). A fifth station in Katete appears to have been built more recently and has not previously been mentioned in the literature. The Chipata Aquaculture Research Station operates as the main hatchery and is where research activities also take place. The other hatcheries operate as decentralised hatcheries to provide fingerlings for nearby farmers in rural areas.

The infrastructure at the government research stations is in need of rehabilitation. Currently, government hatcheries are underutilised and operate below their capacity due to a lack of resources and capacity. The stations struggle to produce large amounts of fingerlings. Moreover, none of them produces sex-reversed fingerlings. In 2017, the Chipata Research Station distributed 46,000 fingerlings to small-scale fish farmers and 240,000 for stocking in SWBs. The Nyanje government fish farm distributed 37,000 fingerlings to 176 fish farmers in Sinda, Petauke and Katete (Table 2). The seed stations continue to struggle with an inadequate water supply, seepage and a general lack of capacity, resources and dilapidated infrastructure to produce a consistent amount of fingerlings.

Other than Chipata, Katete is the only other station with an indoor hatchery. The facility, which seems to have been built more recently, suffers from considerable seepage in the breeding ponds and is currently not operating. The site selection process is unclear, particularly whether consideration was given to soil type in the initial stages of construction. The decentralised fish seed distribution system that was designed to reach fish farmers in the province requires capacity development to increase the availability and accessibility of fingerlings. Government aquaculture stations in Eastern Province require urgent attention in terms of infrastructure rehabilitation, human resources and funding to meet operational costs. The government hatcheries run on public funding and although they sell fingerlings at around ZMW 0.5 per fingerling, this does not cover the costs needed to sustain a consistent seed supply. The findings of fingerling supply and distribution from this study are summarised in Table 3 below.

This study also reports the presence of the first private indoor hatchery in the province, which is still under construction. Mpanga Yala Enterprise has started to build the hatchery in Lundazi with a grant from the International Fund for Agricultural Development (IFAD) under the Enhanced Smallholder Agriculture Promotion Programme (ESAPP). The programme's business model is unclear. The hatchery depends on the demand for fingerlings from fish farmers or from government or donor-driven programmes to stock SWBs.

Table 3: Current status of government hatcheries and a private hatchery in Eastern Province

Station	No. of ponds	Active ponds	Status of hatchery	Current method of fingerling production	Number of fingerlings sold 2017	Requirements for operations to resume/commence
Chipata (Govt)	21	2	Indoor hatchery present but not yet operational Outdoor breeding ponds have high water seepage	Broodstock stocked in dam without hapas (simple fish cages), partial harvest of mixed sex fingerlings	46,000 sold to small scale farmers 240,000 for stocking small water bodies	- Dam repairs to stop leakages - Lining of fishponds - Breeding hapas - Borehole for hatchery - Logistics & operational funds
Chadiza (Govt)	6	0	Outdoor breeding ponds not operational due to high seepage	Not operational	No fingerlings	- Lining of fishponds - Breeding hapas - Logistics & operational funds
Lundazi (Govt)	9	0	Outdoor breeding ponds not operational due to breakdown of siphoning system from dam to fishpond	Not operational	No fingerlings	- Lining of fishponds - Breeding hapas - Siphon replacement - Funding to operate piggery - Logistics & operational funds
Lundazi Mphanga yalala (Private)	3	2	Indoor hatchery present but operation stalled, awaiting further funding	Broodstock in breeding pond without hapas to meet own fingerling needs	No fingerlings	Funding of second phase of project

Station	No. of ponds	Active ponds	Status of hatchery	Current method of fingerling production	Number of fingerlings sold 2017	Requirements for operations to resume/commence
Nyanje (Govt)	9	4	Operational difficulties due to high seepage of breeding ponds	Broodstock stocked in ponds, without hapas, partial harvest of mixed sex fingerlings	37, 000 distributed to 176 farmers in Sinda, Katete & Petauke districts	- Lining of fishponds - Breeding hapas - Logistics & operational funds
Katete Kamphampbe (Govt)	6	0	Indoor hatchery present, not operational	Not operational	No fingerlings	- Lining of fishponds - Breeding hapas - Logistics & operational funds

3.4 Small-scale fish farming

Aquaculture production systems used in sub-Saharan Africa can be differentiated by their extensive, semi-intensive and intensive natures. Systems are on a continuum of intensification, depending on several factors such as technologies, species, level of capital investment, labour and management practices. These three systems exist in Zambia, however the Zambian government characterises them using a rather narrow typology, referring to them as either small-scale or large-scale production systems. This characterisation creates a somewhat blurred line between extensive and intensive systems used by small to medium-sized enterprises, and fails to take into account fish that are cultivated for subsistence *versus* commercial purposes (Genschick et al. 2017). In contrast to this, Kruijssen et al. (2018) differentiate between semi-commercial and commercial systems.

Eastern Province mostly has small-scale, semi-subsistence farmers who produce for household consumption. There are no intensive, commercial systems in the province. Smallholder fish farming systems in Zambia are characterised by extensive farming systems using low cost inputs and family labour (Kaminski et al. 2018). Fish farming systems in small ponds (about 100 m^2 in size) serve to improve household food security and have been popularised by the Rural Aquaculture Project supported by the United States Agency for International Development (USAID) and the United States Peace Corps. The programme was responsible for the increase in households starting fish farming (Mudenda 2009). Over the decades some small-scale fish farmers in the province have been trained by DoF extension officers and camp agriculture officers through various extension programmes (Mudenda 2009).

Farmers with several small ponds may barter their harvest for grain or other food, while others exchange it for agricultural labour during the peak labour season, which coincides with periods when rural households experience food shortages. Stocking is generally low at 1 fish/m^2 and juveniles are either obtained from neighbouring farmers or from the nearest government fish farm. These fingerlings can

range in price, but are generally around ZMW 0.5. Intermittent harvesting is common, and sales are mostly limited to neighbours and local village markets. Pond fertilisation is achieved through composting and the construction of a crib to fertilise the pond (see Fig. 4). As seen from the quality of pond water on the farms visited, farmers do not have adequate animal manure to fertilise their ponds, therefore green leaves are used in compost cribs. This is unlikely to produce the nutrients required for pond fertilisation. The composting cribs observed in this study were empty and generally not adequate for the purposes for which they were maintained.

Figure 4: Composting banana leaves in a pond crib where the water is not yet well fertilised

The farms observed in this study were seldom located around natural water sources (which are rare in the province). Most of the fishponds visited were located in isolation in low-lying valley areas, not too far from established government aquaculture stations. Even if this was not seen during the farm visits for this study, it is possible that fish farmers have formed clusters in certain areas in the district depending on rainfall and the availability of water.

This study showed that the main sources of income for most farmers are agricultural crops and livestock. Fish farming is undertaken as a secondary activity to produce fish for home consumption. This finding is consistent with several studies on Zambian smallholder aquaculture (Kaminski et al. 2018, Kruijssen et al. 2018, Nsonga 2015). The few fish farmers visited during this study carry out fish farming for subsistence purposes in undrainable ponds integrated with crops (mostly banana and sugarcane). Table 4 provides a summary of all the farms visited during the survey.

Most of the farmers use maize bran as feed, often in combination with sunflower or soybean cake or other vegetable material. These materials are mixed and applied as a mash. There is no further processing of the feed materials (*e.g.* feed balls or pelleting). Thus the food conversion ratio (FCR) could be expected to be quite high. Feeding studies by Lundeba et al. (in preparation) have suggested an FCR of around 5:1 in similar systems with homemade feed in northern Zambia. Only one farmer in the sample applied compound feed from a feed company based in Lusaka. This farmer had some capital to build concrete ponds and intended to commercialise his production.

Table 4: Characteristics of some small-scale fish farms in Eastern Province

District	Village	Years in fish farming	Pond			Water supply	Farming system
			#	Total area (m^2)	Pond type		
Chipata	Pelesia	12	3	336	Undrainable ponds of about 1.5 m excavated in gentle valley area	Rain, groundwater, stream	Subsistence – integrated with sugarcane on dykes
Petauke	Philipo	18	7	1,590		spring, groundwater	Subsistence – integrated with bananas on dykes
Lundazi	Lundazi	1	5	400	Concrete	Borehole	Semi-commercial
Lundazi Lumezi	Muntanila	15	1	150	Undrainable ponds of about 1.5 m excavated in gentle valley area	Rain, groundwater	Subsistence
Lundazi Chasefu	Chahero	7	4	250		Spring, groundwater	Subsistence – integrated with sugarcane downstream
Katete	Mphangwe	2	9	2,315		Spring	Subsistence – integrated with bananas on dykes and sugarcane downstream
Sinda	Chikankeni	1	2	800		Groundwater, spring	Subsistence – integrated with vegetables nearby
Chipata Co-op	Malaya & others	15	6	2,400		Groundwater & borehole	Semi-subsistence
Lundazi Co-op	Daila & seven others	16	8	2,400		Groundwater	Semi-subsistence

Access to water seemed to follow a similar pattern across all the districts visited. Most ponds are located in low-lying valley areas where farmers can benefit from groundwater (see Fig. 5), with occasional springs or a rare stream located nearby. The depth of the fishponds in the area varies by season. During the drier period of the year (July-November), water levels gradually decrease to about 1 m or less, although farmers confirmed that water levels were high during the rainy season. Other farms experience water shortages during the dry season, often resulting in ponds completely drying out. Fish farming seems to have become a seasonal activity for most farmers, ending when fishponds dry up in August before the onset of summer. This problem with droughts appears to have increased in recent years (*i.e.* less rainfall, according to the perceptions of the farmers interviewed). This seems to have diminished the motivation for developing fish farming in the area, although this aspect requires further investigation.

Figure 5: Pond excavation process in Chipata showing groundwater seeping before the pond is fully constructed

Fish farming faces a long list of major challenges, most of which have long been observed among small-scale farmers across the country. They include fingerlings of inadequate quality, insufficient animal manure and compost material, a lack of affordable fish feed, a lack of appropriate technology, poor rural infrastructure, a lack of marketing opportunities, insufficient extension packages and inadequate operational funding for research and support to aquaculture stations (ACF/FSRP 2009, Mudenda et al. 2005, Utsugi and Mazingaliwa 2002).

The adoption of smallholder aquaculture could help alleviate poverty and improve rural household food security compared to that experienced by non-fish farming families (Mudenda 2006, Musuka and Musonda 2012). The two cooperatives visited in Chipata and Lundazi (see Table 4) seemed to be exploiting this potential. Fish farmers reported improved access to fish since the projects began. In some instances, the cooperative in Lundazi deliberately made fish available for the most vulnerable members of the community, particularly pregnant women and children.

Figure 6: Fishponds at the small-scale Lundazi Fish Farmers' Cooperative , with cooperative members in the background. The ponds have well-constructed dykes and compost cribs.

The Chipata Malajajest Cooperative owns six fishponds of about 400 m^2 (20 m length × 20 m width × 1.5 m depth) and the Lundazi Fish Farmers' Cooperative has eight ponds of the same size. The cooperatives seem to represent a much more successful model of small-scale fish farming compared to individual farmers in the province. These farmers have more ponds with a larger surface area and well-constructed dykes (Fig. 6). According to DOF standards, these are well-maintained ponds compared to those of individual farmers who have fewer, smaller ponds with uneven dykes (Fig. 7).

Both cooperatives are among the few aquaculture projects in the province to have benefited from donor funding. The Malajajest Cooperative was given a grant by the United States African Development Foundation (USADF), which was used to fence the ponds, dig a borehole and install a pump and generator. The cooperative was initially funded by the Lutheran World Federation. The cooperative in Lundazi received a grant in 2016 from the Enhanced Smallholder Agriculture Promotion Programme

(ESAPP). However, the farmers seemed to have a problem making the project profitable and sustainable as they mostly consumed the fish themselves with very little left for sale. In 2017, the Lundazi Fish Farmers' Cooperative harvested only 70 kg of fish from the eight fishponds (293 kg/ha) and shared 40 kg, mostly among pregnant women and children, while the rest was sold. In the same year, the Chipata Malajajest Cooperative harvested a total of 250 kg at about 100 grams per fish from six fishponds (1041 kg/ha) and sold their fish at ZMW 20 per kg to members and ZMW 30 per kg to non-members. This money was used for operating costs, such as purchasing diesel to run the generator to pump water into the fishponds. However, the cooperatives do not keep records and are not currently operating as businesses.

Members seemed motivated and knowledgeable about the ongoing activities and seemingly benefited from sharing knowledge, learning and experience. This was in contrast to some individual farmers who were attempting to farm fish with little experience, knowledge or extension support. The cooperatives evidently received training and support from fisheries officers at their inception, although farmers still stated that they required more training. Due to a lack of natural resources for fish farming in the province (water, soil and land) and a lack of knowledge, inputs and extension support, it appeared that people could engage in fish farming more successfully through collective action by forming cooperatives.

Figure 7: Small uneven ponds with poorly constructed dykes

3.5 Seasonal calendar of farming activities

Two focus group discussions revealed the seasonality of aquaculture and the availability of other farm products. The rainy season begins in December and ends by April, and farmers grow rain-fed crops such as maize, soybeans, groundnuts, beans, cotton and cassava. This period just before and during the early rains is the busiest time for farming activities. Land preparation begins by September and tilling is mostly done using oxen and hand-held tools. December to mid-January is the planting time for most crop varieties.

Figure 8: A focus group discussion underway with a dam management committee in Lundazi

Fishpond digging usually starts in August and runs until November because this is the drier time of the year and excavation is more convenient. This period of heavy work of pond construction coincides with the time needed to prepare the land for crop planting. Farmers with several small ponds may barter fish in exchange for agricultural labour time during this peak labour season, which also coincides with periods when rural households experience food shortages (Mudenda 2009). Stocking of fishponds mostly takes place from March to May since this is the time when ponds collect enough rainwater. Harvesting of fish starts in June and continues until October. The fish-rearing cycle is around six months and stops when water levels begin to recede. Some farmers are forced to completely harvest all their fish by August because their ponds dry up completely. Fishponds are usually harvested when the fish reach between 80 and 200 grams. Since there are no sex-disaggregated fingerlings, fish multiply, which results in a wide

range of fish sizes. Overall, few fish reach a weight of more than 200 grams owing to poor management techniques.

Table 5: Seasonal calendar for fish farming cooperative groups in Chipata and Lundazi

	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Rainfall				■	■	■	■					
Aquaculture activities												
Pond digging	■	■	■									■
Stocking							■	■	■			
Fertilisation & feeding	■	■	■	■	■	■	■	■	■	■	■	■
Harvesting	■	■								■	■	■
Marketing	■	■								■	■	■
Main food sources												
Maize	■	■						■	■	■	■	■
Cassava	■	■	■			■	■	■	■	■	■	■
Beans	■					■	■	■	■	■	■	■
Groundnuts	■	■				■	■	■	■	■	■	■
Main income sources												
Maize	■	■										■
Groundnuts	■	■								■	■	■
Cassava	■	■				■	■	■	■	■	■	■
Soybeans									■	■	■	■
Sunflowers							■	■	■	■	■	■

The main food crops are maize, cassava, soybeans and groundnuts. They are usually planted from December to January and harvested from June to October. These food sources are abundant for home consumption during the harvesting period, but drastically decline from November to February as most of the harvest is sold for cash income. Therefore periods of food shortages occur at the time when rural households have the least income. Coincidentally the lean season falls in the rainy season when farmers need resources to prepare their fields. The seasonal calendar with detailed information is shown in Table 5.

In areas with a perennial water supply and located near dams, fish farming could ensure the availability of fish for home consumption and for sale or barter during this crucial time. Fish farming could provide an alternative source of food and income during the most challenging times of the year.

3.6 Small water bodies

To assess the opportunities for small water bodies and fish production, five dams were visited in three districts, focus group discussions were held with dam management committees and interviews were conducted with key informants. Most of the SWBs were constructed in the 1950s and 1960s and rehabilitated between 2008 and 2016. SWBs are usually rainfed and/or groundwater-fed and store water all year round. Around 1,000 to 5,000 people living around the dams have access to the resource and are allowed to use the water for livestock, irrigation, fishing activities and domestic use (washing of clothes). The water is not used for drinking because the villages generally have separate boreholes and wells.

In order to strengthen food security in areas with communal water bodies, stocking of fish in existing water impoundments is one promising approach (Mudenda 2009). This has happened in the district of Chipata, where 10 small water bodies were recently stocked with fish under the Scaling Up Nutrition (SUN) programme in 2017 (see Table 7. The Zambian Government is implementing the SUN programme through the National Food and Nutrition Commission. It is expected that after taking up fish-raising activities, the surrounding communities will benefit from easy access to fish, which will in turn increase their protein intake and nutrition, especially for children and pregnant women. In Mambwe district an NGO plans to install cages on Chiwoko dam, which will benefit the surrounding villages. Chiwoko Dam, which was recently established in 2017, is around 15 m deep. The dam has been invaded by an aquatic weed (water hyacinth), which needs to be cleared before any further aquaculture development can take place (see Fig. 9). This weed was not encountered in any of the other dams visited. Some water bodies are in need of de-silting and dyke repairs as part of the development process.

Figure 9: Chiwoko Dam in Mambwe district invaded by water hyacinth

The dams have been fished for many years, with fish either entering naturally or being stocked in the water bodies. Most of the dams visited had been stocked on one occasion, either initiated by the DoF or by a donor programme. Only 15 out of around 100 dams were stocked in the six districts visited (see Table 6). Key informants stated that many dams have been depleted of fish for years. Dams recently stocked in 2017 under the SUN project have not yet been opened for fishing after a two-year fishing ban was instated following stocking to allow the stocks to increase. This led to the formation of dam management committees in certain areas to enhance conservation and management of the fishery resource.

Table 6: Management characteristics of dams visited during the study

District	Year of construction	No. of persons using dam	Management method	Last stocked	No. of fingerlings stocked	Fish species
Petauke, Kaulu dam	1948, 2008 rehabilitation		Dam management committee	2008 by DoF	25,000	Tilapia, catfish, crossbreeds of O. niloticus
Petauke, Lusowe dam	1965	5,000	Dam management committee, applied for certified cooperative	1967 by Council	?	Catfish, tilapia, kapenta
Chipata	1958, rehabilitation 2016	1,500	Dam management committee and camp agricultural committee	2017 under SUN	20,000	Tilapia, catfish
Lundazi, Tigone dam	1967, 2008 rehabilitation	3,000	Dam fisheries co-management	2009 by DoF	3,300	Tilapia, Kapenta, catfish
Mambwe Chiwoko dam	2018	5,000	Dam management committee	Never	-	Natural fish stock: tilapia, catfish

Figure 10: Small fish are commonly found in most of the dams

Dam management committees are elected by surrounding villages and given some legality through traditional leaders. The committees' main duties are to maintain the dams and manage the fisheries as a communal resource, but they do not own the dams. They rely on moral force and traditional authorities to govern. Some well-managed committees are able to collect fishing fees from fishers and confiscate any illegal fishing gear such as mosquito nets. They enforce a fisheries ban from 1-28 February every year, even though the statutory fishing ban only applies to commercial fishery areas such as Lake Kariba (Mudenda, 2009). Some dam management committees are being turned into cooperatives which have more "governmental authority" governed by bylaws and with an annual subscription for membership. However, the effectiveness of these cooperatives compared to dam management committees has not yet been evaluated.

Table 7: Dams stocked under the SUN project – Chipata district

Date stocked	Dam	Ward	GPS Location	No. of fingerlings
14/06/17	Mwita	Chipangali	S13.28281° E032.80852°	10,000
16/06/17	Phawa	Kapatanthope	S13.22448° E032.64469°	15,000
19/06/17	Kamunduwi	Kapatanthope	S13.37732° E032.55175°	15,000
22/06/17	Sazu	Chikando	S13.88699° E032.47258°	10,000
23/06/17	Chilobwe	Chikando	S13.78432° E032.46089°	12,000
27/06/17	Rukuzye	Chipangali	S13.35059° E032.81159°	20,000
07/07/17	Mapala	Chipangali	S13.34180° E032.83950°	20,000
11/07/17	Nkalikali	Chipangali	S13.14675° E032.77063°	18,000
14/07/17	Lumamba	Chipangali	S13.19742° E032.78010°	20,000

3.7 Fish availability and consumption

During this study a total of 57 consumers (15 female, 42 male) in five districts were interviewed about their food insecurity experience scale (FIES) and their access to and consumption of fish. The consumers were divided into five different categories according to their location or activity related to fish (fish farmer, fish trader, urban, rural with access to ponds/dams and rural without access to ponds/dams) (Table 8).

Table 8: Categories of consumers interviewed during the study				
Consumer	**Total no. of respondents**	**Women**	**Men**	**Districts**
Fish farmer	13	1	12	Chipata, Sinda, Katete, Petauke, Lundazi
Fish trader	7	3	4	Chipata, Lundazi
Urban	13	6	7	Chipata
Rural (access to ponds/dams)	20	3	17	Petauke, Lundazi
Rural (no access to ponds /dams)	4	2	2	Chipata
TOTAL	**57**	**15**	**42**	

With regard to FIES, these results show that overall 13 individuals were "food secure" (2 women, 11 men), 8 "mildly food insecure" (5 women, 3 men), 11 "moderately food insecure "(2 women, 9 men), and 25 "severely food insecure" (6 women, 19 men) (see Fig. 11).

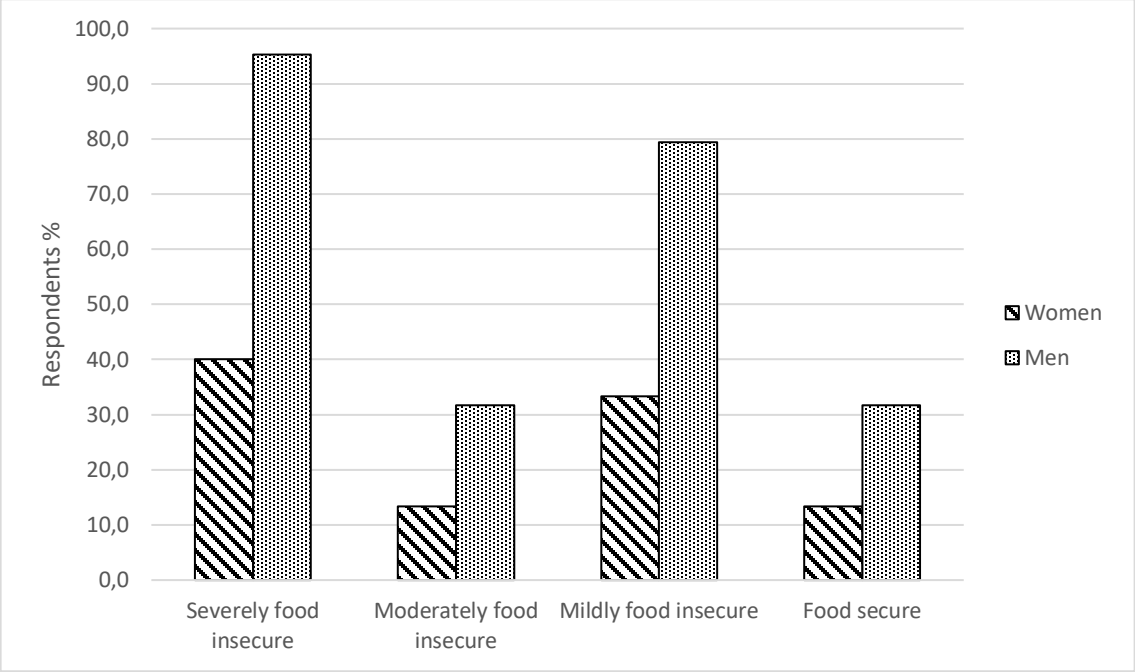


Figure 11: Number and gender of persons according to their FIES

In relation to their wealth status, most "severely food insecure" respondents were poor, whereas no better-off consumers were found to be "severely food insecure", but instead tended to be "food secure", according to the FIES criteria. The results of the moderately wealthy people varied and no clear picture emerged. Similar proportions were found in all four categories, with the majority being either "severely food insecure" or "food secure" (Fig. 12).

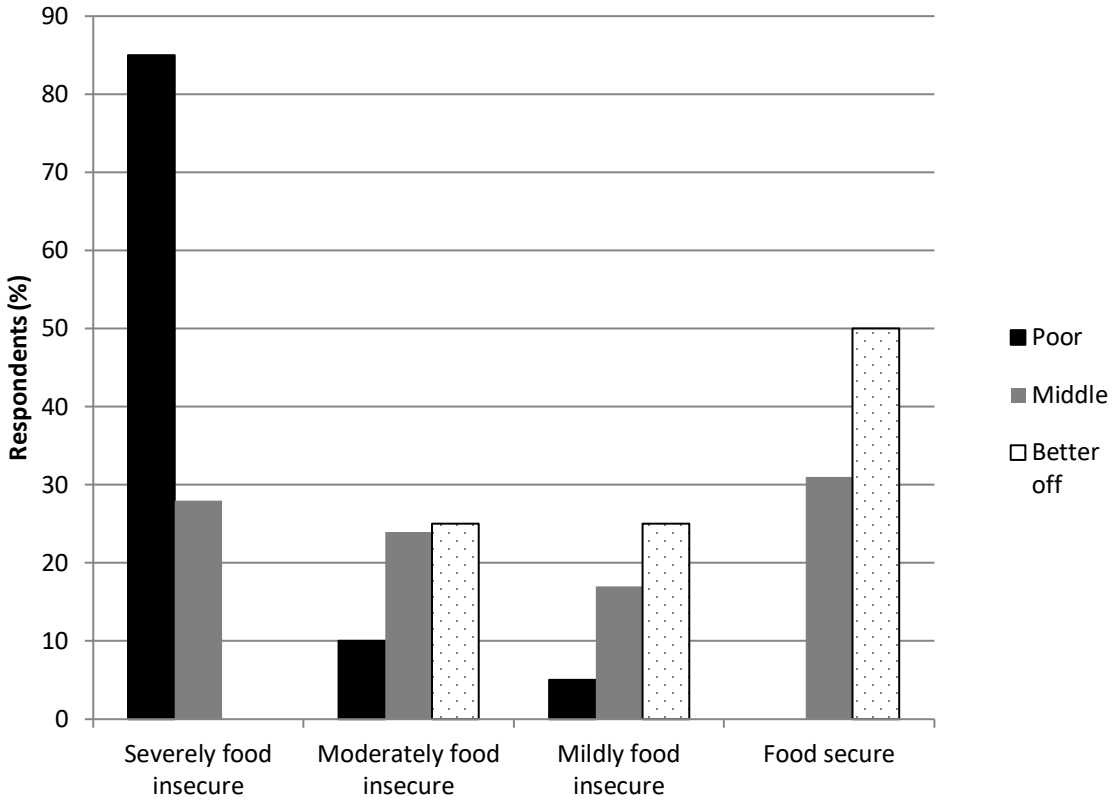


Figure 12: FIES of consumers (%) divided by wealth categories

Figure 13 illustrates the comparison of the FIES of the five different consumer categories in this sample. People living in urban areas seemed to be less prone to severe food insecurity (8 %), but the same percentage (31 %) of urban dwellers was found in the other three scales. People who lived in rural areas without direct access to fishponds or dams seemed to be at a higher risk of being "severely food insecure". This hypothesis requires more research as the sample size for this category was too small for representative conclusions to be drawn. The highest percentage of rural people with access to fishponds or dams were "severely food insecure" (60 %), a smaller percentage were "moderately food insecure" (20 %) or "food secure" (15 %), and the remaining 5 % were "mildly food insecure". Fish traders were found, at the same percentages, to be either classified as "food secure" (31 %) or as "severely food insecure" (31 %). Individuals who farmed fish were found in all four scales, with 46 % of fish farmers being classified as

"severely food insecure" and 31 % as "food secure". More research and larger sample sizes are necessary to understand the role of fish in helping to improve the food security of fish farmers.

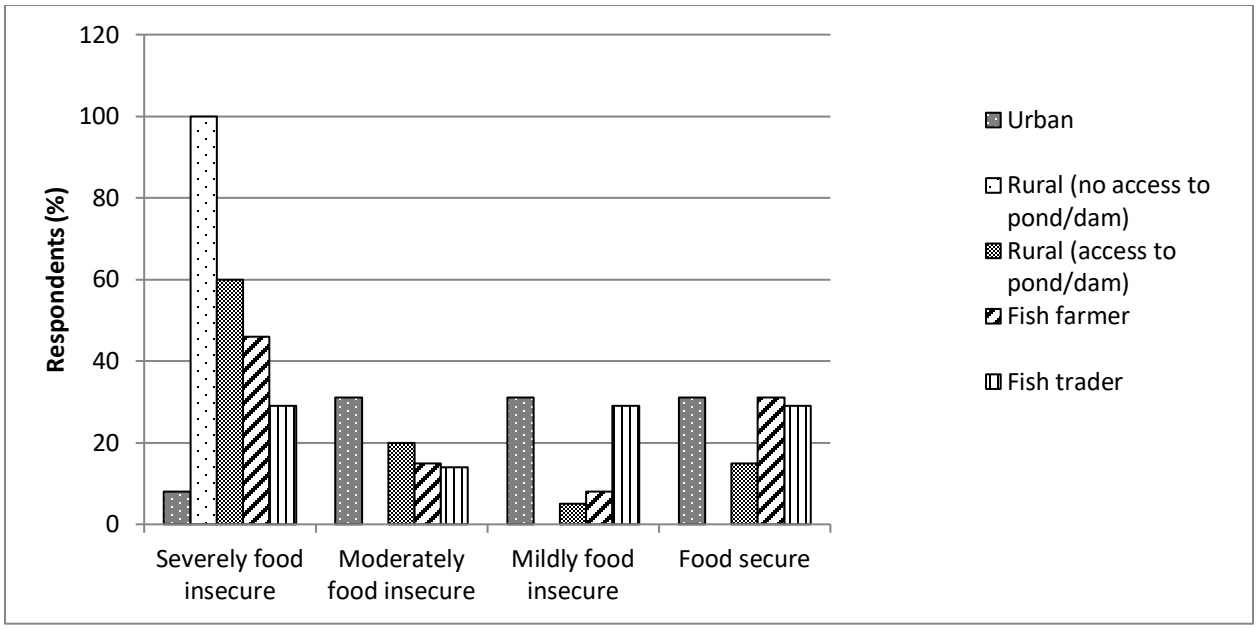


Figure 13: FIES of consumers (%) divided by consumer category

3.7.1 Fish consumption tendencies by consumer classes

The frequency of fish consumption and the most common sources of fish were assessed. In total, 52.6 % of respondents ate fish on a weekly basis, 28 % monthly, 10.5 % yearly and 8.8 % "had not eaten fish in a long time". When asked about the sources of fish, 48 % of consumers mostly purchased the fish from local markets, 21 % got most of their fish from fishponds, 10 % caught fish in nearby streams and 11.5 % used dams (SWBs) as their main source of fish. Fewer respondents purchased fish from fishermen (5.7 %) or from supermarkets (5.8 %).

Second, the respondents were asked about the last fish they bought/caught and gave information about the species, estimated the amount (in grams) and the value of this fish product (in ZMW). This information together with the frequency of fish consumption and the number of household members was used to calculate the yearly fish consumption in kg/capita. The average fish consumption from the whole sample (n=57) was 7.32 kg/person/year.

To get a clearer picture of fish consumption, the five different consumer groups were analysed (see Table 9). Compared to the other consumer groups, fish farmers (n=13) consumed the greatest average amount of fish (10.66 kg/person/year), followed by urban households (n=13) with an average yearly consumption of 9.20 kg/capita. Rural households with access to fishponds/dams (n=20) ate on average 6.8 kg/person/year. A slightly lower amount was found for fish traders (n=7), who consumed around 5.97

kg/person/year. The lowest average fish consumption was found in the group of rural households without access to ponds/dams (n=4) who ate only 1.2 kg/person/head.

Regarding the sources of fish and the frequency of consumption, the data showed that fish farmers mainly harvested the fish from their own fishponds (77 %) and ate fish weekly or monthly. Urban households tended to buy fish weekly at the local market. Rural households with access to dams/ponds mainly consumed fish weekly or monthly, however five individuals stated that they "haven't eaten fish in a long time" (*i.e.* "never"). The most common sources of fish for this group were local markets (35 %) and dams (25 %). Rural households without access to dams/ponds mainly purchased fish weekly from local markets. The same applied to fish traders.

Table 9: General frequency of fish consumption

Consumer	Frequency of fish consumption (no. of consumers)	Typical source of fish (no. of consumers)	Average amount of fish consumed (kg/person/year)
Fish farmers (n=13)	Weekly 6 Monthly 5 Yearly 2	Fish farm 10 River/Lake 3	10.66
Fish traders (n=7)	Weekly 5 Monthly 1 Yearly 1	Local market 4 Fishermen 2 Dam 1	5.97
Urban (n=13)	Weekly 10 Monthly 3	Local market 10 Supermarket 2 River/Lake 1	9.20
Rural (access to ponds/dams) (n=20)	Weekly 6 Monthly 6 Yearly 3 Never 5	River/Lake 1 Dam 5 Local market 7 Supermarket 1 Fish farm 1	6.80
Rural (no access to pond/dam) (n=4)	Weekly 3 Monthly 1	Local market 4	1.20

3.7.2 Fish consumption by FIES group

This section analyses the consumption of fish by FIES groups. Table 10 gives an overview of the average yearly consumption of fish in kg per person. Food-secure individuals consumed over 12 kg of fish per person/year, whereas severely food-insecure people consumed 3.56 kg/person/year.

Table 10: Average fish consumption (kg/person/year) per FIES group

FIES group	Average consumption of fish (kg/person/year)
Food secure (n=13)	12.17
Mildly food insecure (n=8)	7.89
Moderately food insecure (n=11)	11.07
Severely food insecure (n=25)	3.56

Figure 14 displays the fish consumption (kg/person/year) of the different FIES classes by the five consumer categories. Among the food-secure group, rural households with access to ponds/dams (n=3) consumed the greatest amount of fish (17 kg/person/year). However, one person from this group stated that they ate 44 kg of fish per person/year in his household, which greatly inflated the number. Urban food-secure individuals (n=4) ate on average 13 kg of fish per person/year, followed by food-secure fish farmers (n=4) (9.8 kg/person/year) and fish traders (n=2) (7.5 kg/person/year). Comparing this numbers to severely food-insecure groups, a clear pattern could be observed. Severely food-insecure urban households, fish traders and rural households without access to ponds/dams consumed 1.04, 1.15, and 1.2 kg/person/year respectively. Severely food-insecure rural households with access to ponds/dams consumed on average double the amount, at 2.14 kg/person/year. In this latter group the greatest amount of fish consumption was observed among severely food-insecure fish farmers (n=6) who consumed 8.24 kg/person/year.

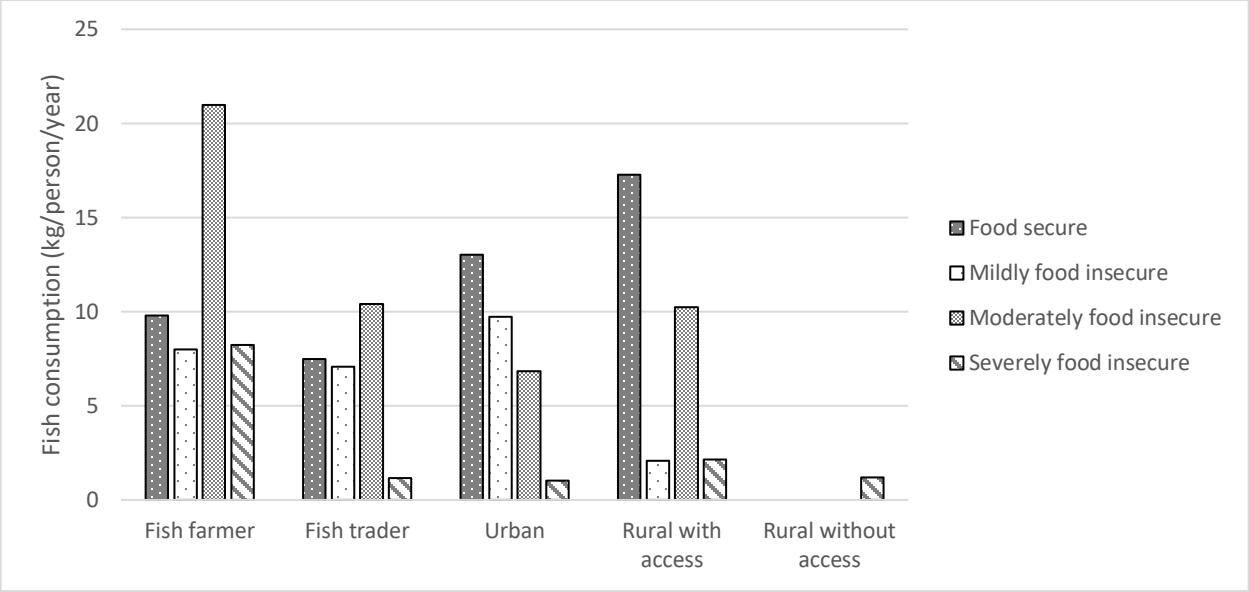


Figure 14: Fish consumption (kg/person/year) per FIES group and consumer class

3.7.3 Most commonly consumed fish species by consumer classes

The most commonly "last consumed fish species" from the sample was tilapia (63.5 %), followed by kapenta (23.1 %). Less frequently consumed fish species were catfish (4 %) and others, probably including a mixture of small wetland species and possibly imported fish such as horse mackerel (10 %). Of the fish species consumed, 61.5 % were fresh and 38.5 % were dried.

Most urban individuals purchased whole, fresh tilapia last (46 %) and 15 % stated that they bought dried kapenta last. Rural populations with access to ponds/dams also consumed fresh, whole tilapia (33 %), followed by fresh small fish species ("kapenta") (27 %). All respondents in the "rural without access to pond/dam" category exclusively purchased "dried kapenta" and 69 % of the fish farmers ate fresh tilapia, while only 4 % purchased "fresh kapenta" last. Fifty-seven of the fish traders purchased other fish species, meaning that they bought the greatest variety of different fish species (see Fig. 15).

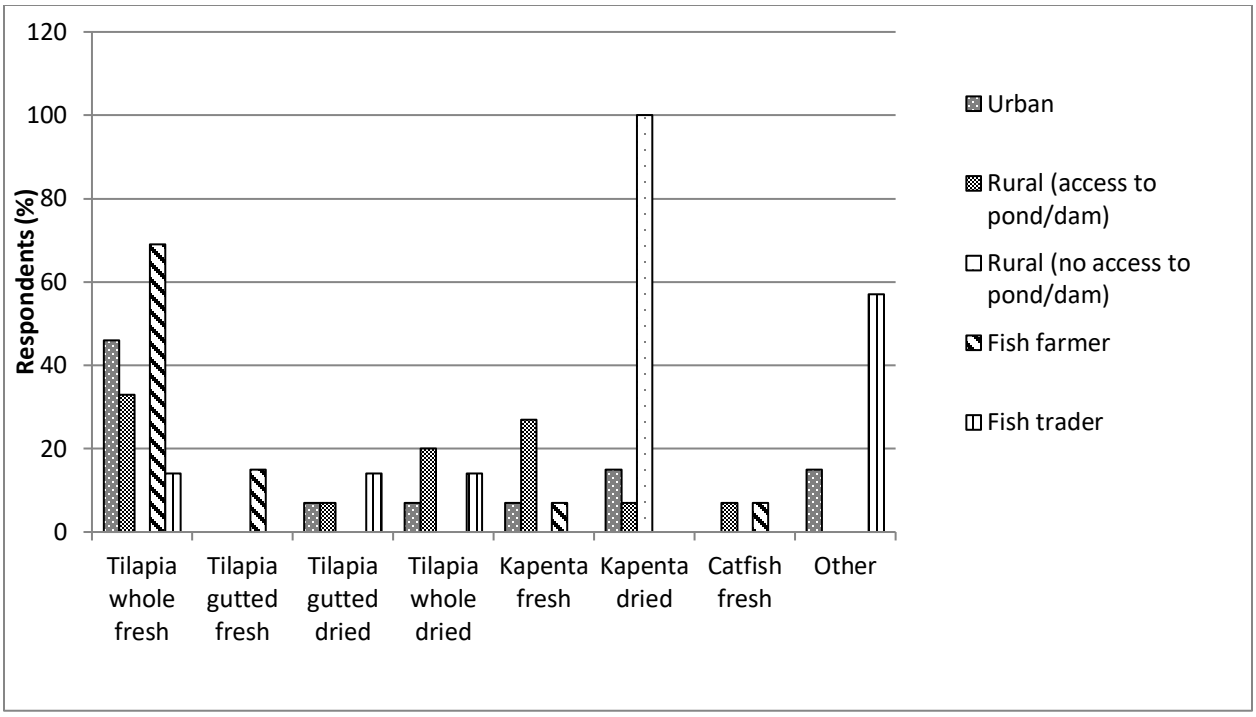


Figure 15: Last consumed fish species and form of fish by consumer category (%)

3.7.4 Most commonly consumed fish species by FIES group

Figure 16 gives information about the type of fish last consumed by FIES groups and how much the different fish products cost on average. Most of the "food secure" (53 %), the "mildly food insecure" (62 %) and the "moderately food insecure" (40 %) individuals consumed fresh whole tilapia. Fewer than 3 % of the "severely food insecure" persons consumed fresh whole tilapia. Most of the "severely food insecure" group (28 %) consumed "dried kapenta", followed by "no fish" (19 %) and "fresh kapenta" (14 %). No one from the "food secure" and "mildly food insecure" group was found to have purchased "dried kapenta" or "no fish".

Recall data was used to calculate the prices, and in some cases the respondents had to estimate the value of fish if the fish was caught or provided for free. This might explain the great variation in prices. The price for the different processed forms of tilapia varied between 13 ZMW/kg for gutted, fresh fish and 54 ZMW/kg for gutted, dried tilapia. Consumers stated that they paid on average 31 ZMK/kg for whole, fresh tilapia. For fresh and dried kapenta the prices were higher and interviewees paid around 55 ZMK/kg. To explain why "moderately" and "severely food insecure" groups tended to buy more expensive fish species, their purchased quantities need to be taken into consideration. For instance, consumers who purchased dried kapenta as "the last fish species" bought on average 214 g for 11 ZMK compared to individuals purchasing tilapia, who bought on average 1875 g for 45 ZMK.

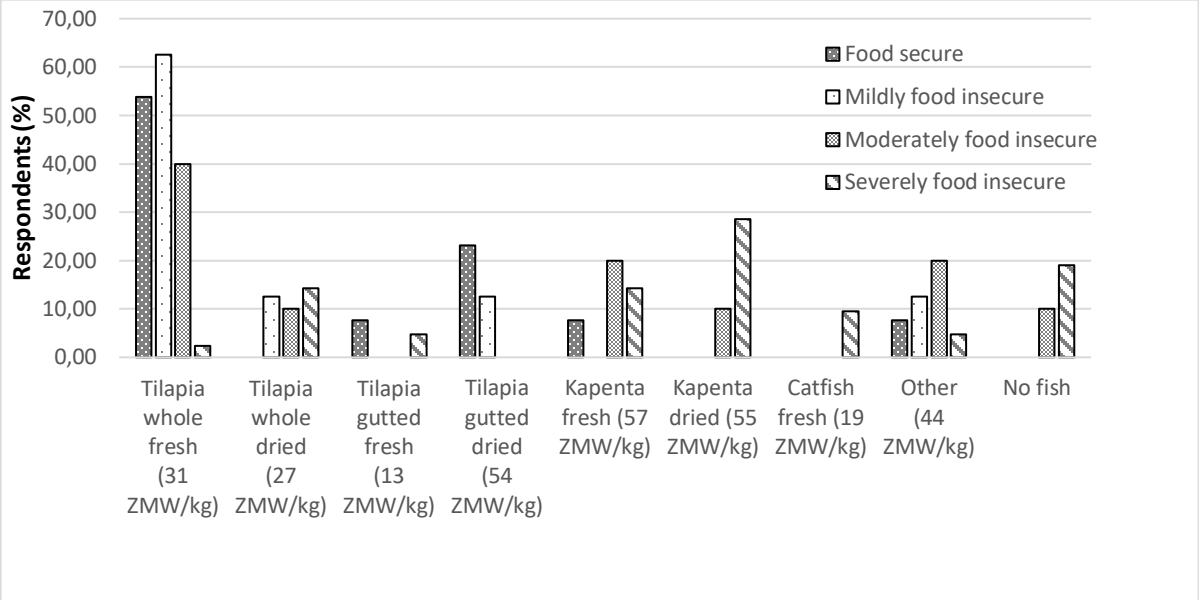


Figure 16: Last consumed fish species, form of fish and price/kg by FIES group (%)

3.7.5 Fish market survey

During the present study, the team visited two local markets, one in urban Chipata and the other in rural Lundazi. There were various dried fish species available from various capture fisheries, *e.g.* small, pelagic species from Lake Tanganyika, Lake Kariba, Lake Victoria (Tanzania) and Lake Malawi. Dried and gutted tilapiine breams, tigerfish (*hydrocynus vittatus*) (medium-large sizes), and many other freshwater species (whole and dried) were purchased from fishermen operating on the Luangwa River.

During the annual fishing ban in Zambia (December-March) fish is supplied from Tanzania, Mozambique and Malawi. Mussa et al (2017) observed that the most commonly imported fish into Zambia from Malawi includes usipa (*Engraulicypris sardella*), a small pelagic species from Lake Malawi and some other fish species such as matemba (*Barbus paludinosus*), utaka (*Copadichromis* species), chambo (*Oreochromis* spp.), mlamba (*Clarias gariepinus*), ncheni (*Rhamphochromis* spp.), mbaba (*Buccochromis* spp.), njole (*Labeo altivelis*), makakana (*Oreochromis mossambicus*), Jamison (*Diplotaxodon argenteus*) and carapau (*Scomber* spp.). A further observation was that the intra-regional fish trade has the potential to address the region's food and nutrition insecurity, as well as poverty reduction, by enabling movement of fish from countries of surplus to those with a deficit. Therefore, it is important for countries in the Southern African Development Community (SADC) to regularise and formalise cross-border trade, particularly in small pelagic fish species, since these species play a great role in the livelihoods, food and nutrition security of many people in the region, especially the rural and urban poor (Mussa et al. 2017).

Figure 17: An interview with a fish trader at Lundazi market with dried opened and closed tilapiine bream on display

This study identified some species of imported dried fish in the local markets of Chipata and Lundazi as reported by Mussa et al. (2017). Dried tilapiine species imported from Mozambique were also a major species at the market (see Figure 17). The most common Zambian fish species found in the markets included tilapia (sundried *Tilapia* spp.), bottle fish (*Mormyrus longirostris*), buka-buka (*Lates stappersii*), catfish (*Clarias gariepinus*), tigerfish (*Hydrocynus vittatus*) and two types of kapenta; *Strothrissa tanganicae* (Mpulungu) *and Limnothrissa miodon* (Siavonga). The prices of some fish species found in Chipata and Lundazi are shown in Annex 5.

The challenges experienced by fish traders in markets included shortage of fish supply, poor quality fish, high transport costs, especially because of the proximity of Eastern Province to Zambian capture fisheries and fish trade routes and finally, at times, too much fish on the market during certain periods leading to poor sales.

Fresh fish in urban areas were also found in outlet stores of Capital Fisheries Ltd. (Lundazi and Petauke) and also one branch of the domestic aquaculture producer Lake Harvest (Chipata). In Chipata, Yalelo, another domestic cage-producer, had an outlet store where 15-18 tonnes of fresh and frozen Tilapia from Lake Kariba were sold per month. The store has been operating in Chipata since April 2017 and a number of supermarkets sell frozen and dried fish species from the Capital Fisheries Ltd. branch. Little difference was observed between these prices and the prices of other fresh tilapia species available on the market.

3.7.6 Key findings on fish consumption

The results suggest that fish in urban areas is mainly supplied from two different sources. The first is wild fish from various capture fisheries in and around Zambia, which is mostly dried and transported long distances. While Chipata is well positioned in the Malawi-Zambia fish trade corridor, there is less fish being transported to rural areas in Eastern Province. People in rural areas are therefore more dependent on local water bodies (rivers and streams), including SWBs, and whatever fish they can harvest from earthen ponds. The majority of fish in urban areas is dried, although there are new forms of fish (frozen and fresh) found in supermarkets and retail outlets of import companies and domestic aquaculture producers. This is confirmed by Kaminski et al. (2018) who observed the emergence in Zambia of improved cold chains and vertically integrated marketing strategies of large fish distributors and aquaculture companies.

Fresh tilapia was the most preferred fish species, and interviews with representatives from Yalelo emphasised that the demand for tilapia was high. There was little competition from smallholder fish farmers either from Zambia or Malawi. No farmed fish from smallholder producers was found in any markets in the survey.

These data show that 77 % of fish farmers stated that their main source of fish was their own fishpond, which clearly indicates that farmed fish is self-consumed. Another indicator that fish farming could contribute to improved access to fish and greater food security was the finding that fish farmers consumed the largest amounts of fish compared to other consumer classes (10.66 kg/person/year). This amount was close to the national average of 11 kg/capita/year (Kaminski et al. 2018). Regarding the FIES groups, it could clearly be seen that "severely food insecure" fish farmers still consumed more than 8 kg/person/year, compared to other "severely food insecure" consumer classes that only ate around 1-2 kg/person/year. These findings support the hypothesis that fish farming could contribute to food security.

Another result, also confirmed in the literature, was that a common source of fish for severely food-insecure households are small, dried kapenta from capture fisheries that are bought in small quantities (Kawarazuka & Béné 2011; Longley et al. 2014). The price for this fish product is high at around 55 ZMW/kg, compared to tilapia, which can be found at around 25-30 ZMW/kg. One reason why small, "dried kapenta" is still the most purchased fish product for food-insecure groups could be that it can be bought at small and still affordable quantities compared to larger sized tilapia. Another reason may be the accessibility of this fish product since access to fish seems to be more difficult and the main constraint to rural households in Zambia purchasing fish (NFDS Africa 2014). Small, dried fish can also be easily stored and transported over long distances to rural areas, making it more accessible (Beveridge et al. 2013, Longley et al. 2014).

The data from rural villages with access to fish from ponds and SWBs showed that these households consumed greater amounts of fish (on average 6.8 kg/person/year) and mainly fresh fish (78 %) compared to rural people without access to SWBs, who consumed on average only 1.2 kg/person/year. Also, previous studies confirmed that people with access to reservoir fisheries consume significantly more fish than people without access (ALCOM 1997). However, the data for the consumer group with access to

ponds/dams showed some varying trends. Five individuals stated that they had not consumed fish in a long time because there were no sources of fish as food nearby. This could be explained by the depletion of the fish stocks in some of the SWBs that was mentioned during focus group discussions with dam management committee members. Regarding the use of fish caught in dams, dam management committee members confirmed that most of the fish caught was used for home consumption or sold within villages, and that the dams helped to increase access to fish. Site visits during the research confirmed that women and children had access to this fishing resource and caught small quantities of various fish species with lines and hooks for direct home consumption.

4 Recommendations

Based on the results of this assessment, the potential of aquaculture and fisheries is not as high in Eastern Province as it may be in other provinces in Zambia. However, there are some important aspects to consider for further aquaculture and fisheries development in the province:

1. Since permanent sources of water, such as perennial rivers and lakes, are scarce in the region, SWBs are vitally important sources of fish. Nutritious, fresh fish can contribute to an increased intake of protein and micronutrients in the diets of the rural population. Furthermore the SWBs are important sources of water for irrigation purposes and for livestock. This is becoming increasingly important in the face of climate change, which is projected to increase the frequency, length and intensity of droughts. Large sources of water can be crucial for additional climate change adaptation strategies and the development of climate-resilient food systems, especially for vulnerable populations with high nutrient deficiencies. Further exploration of culture-based fisheries, dam-based fisheries management, cage culture in SWBs and/or using SWBs as a water source for pond farming should be undertaken. Before initiating any aquaculture development programme in these dams, a full analysis of water quality parameters (DO, pH, alkalinity *etc*.) should be undertaken. Dam characteristics such as prevailing wind direction, surface area and depth vary from one dam to the other.
2. Small water bodies have great potential to contribute to fish production in the province. Cage culture, if introduced in dams, could benefit the community through intense production, developing a high biomass of fish. This could also result in secondary nutrient transfer (*i.e.* spill-over) to other fish species in the dam since they are not fed and dams are unfertilised. Aquaculture and capture-based fisheries can complement each other in small water bodies, although this needs to be carefully regulated to avoid rampant commercialisation and environmental degradation. Any exploration of cage culture ventures will require comprehensive studies of the socioeconomic and power relationship context, as well as the economic viability of various business models, *i.e.* whether through dam management committees, cooperatives or public private partnerships (PPP) *etc*.
3. From a nutritional perspective, these findings suggest that people with access to reservoir fisheries consume more fish than people who do not have access. An appropriate management

of SWBs that aims to increase productivity through stocking and/or feeding/fertilising activities could enhance the fisheries and the fish yield. To ensure a sustainable and equitable use of the common resource, all relevant stakeholders, including DoF, traditional authorities and communities around a reservoir need to be involved. Meetings with dam management committee members revealed concerns about a depletion of fish stocks and lack of control over fishing activities. For sustainable management it is essential to cooperate with all the villages around a reservoir to empower them in managing and monitoring the fish resource and secure user rights.

4. The Zambia-Malawi fish trade corridor provides unique opportunities for potential fish farmers and traders. There is a large volume of dried pelagic fish products moving between the two countries and this corridor is vitally important for fish traders, many of whom are women. Improved markets, post-harvest processing and trading would allow larger, better quality supplies of fish to service both countries. The fact that Zambia exports fish feed for aquaculture purposes to Malawi also means that feed travels between Lusaka and Lilongwe through Chipata. This could be of major importance should cage culture be developed in existing SWBs.

5. The existing basic infrastructure for fingerling production is rather unique to Eastern Province. It is unclear why there is a decentralised fingerling production system in Eastern Province as compared to other provinces in Zambia. This development was probably influenced by previous governments and/or donor-driven projects. For a province with so few fish farmers and so many SWBs, this could greatly contribute to improved fingerling supply. While the infrastructure and capacities of hatchery staff in Eastern Province require an influx of funding and resources, these investments could greatly develop fingerling supply, potentially for Malawi as well. It could also be an important dissemination area since *O. andersonii*, currently being enhanced through a genetic improvement programme, is also endemic to the Luangwa River basin.

6. Government aquaculture stations have great potential for investment in fingerling production and semi-commercial production of table fish. The decentralised hatchery system could be rehabilitated to provide fingerlings for farmers, but also for stocking in culture-based fisheries. It is necessary to explore the possibility of PPPs for some of these facilities with potential private investors. Appropriate business models for the hatchery grow-out system would need to be developed and implemented stepwise.

7. Small-scale fish farmers could be clustered in groups in high potential zones with perennial water availability and good access to markets. These areas have their own management challenges, such as poor pond fertilisation, an inability to dry and lime ponds, leaching of nutrients *etc*. However, there are appropriate technologies for fish culture in undrainable ponds (Kumar 1992). Since aquaculture can be profitable over a wide range of intensities, there is a need to identify appropriate production systems that may be suitable for commercial, semi-commercial and subsistence fish farming in the area.

8. Extensive small-scale fish farming systems typically use manure and supplementary feeding of plant by-products such as maize bran, but production levels are generally very low. Access to good quality fingerlings, compounded feed and consistent extension services will help raise

production levels. Different crops are grown in Eastern Province, such as maize, soybeans, groundnuts and sunflowers. Most grains are currently transported to milling companies located in Lusaka and animal feeds are imported into the province, thereby making feed costs very high. To reduce the costs of animal feeds, farmers could be trained to produce their own home-made fish feed with the use of especially protein-rich crops.

5 Bibliography

ACF/FSRP (2009). The Status of fish population in Zambia's water bodies.

ALCOM (1988). Field Testing of Aquaculture in Rural Development Pilot Project. Eastern Province Zambia. Report in Draft for 1988 ALCOM/FAO/SIDA. GCP/INT/ 436/SWE. 58p.

ALCOM (1997). Van der Mheen, H. & van der Mheen-Sluijer, J. Reservoir Fishery in Eastern Province of Zambia. Food and Agriculture Organization of the United Nations. GCP/INT/555/SWE.

African Development Bank (2016). Aquaculture Enterprise Development Project Zambia. OSAN/SARC/ZMFO.https://www.afdb.org/fileadmin/uploads/afdb/Documents/Project-and-Operations/Zambia_-AR-_Aquaculture_Enterprise_Development.pdf.

Ballard, T.J.; Kepple, A.W. & Cafiero, C. (2013). *The food insecurity experience scale: development of a global standard for monitoring hunger worldwide.* Technical Paper. Rome, FAO. (available at http://www.fao.org/economic/ess/ess-fs/voices/en/).

Beveridge, M.C.M.; Thilsted, S.H.; Phillips, M.J.; Metian, M.; Troell, M. & Hall, S.J. (2013). 'Meeting the Food and Nutrition Needs of the Poor: The Role of Fish and the Opportunities and Challenges Emerging from the Rise of Aquaculture', *Journal of Fish Biology* 83: 1067–84.

Department of Fisheries (DoF) (2015). 2014 Fisheries Statistics Annual Report. Fisheries statistics and information management unit. P.O. Box 350100 Chilanga, Zambia.

Department of Fisheries (DOF) (2018). 2017 Fisheries Statistics- Annual Report. Lusaka Zambia.

Gopalakrishnan, V. (1988). Role of Tilapia (Oreochromis andersonii) in integrated farming systems in Zambia. In Pullin, R. S. V.; Bhukaswan, T.; Tonguthai, K; Maclean, J. L. (Eds.). Second International Symposium on Tilapia in Aquaculture, March 16 –20. ICLARM, Manila, Philipines.pp. 21 –28.

Genschick, S.; Marinda, P.; Tembo, G.; Kaminski, A.M.; Thilsted, S.H. (2018). Fish consumption in urban Lusaka: The need for aquaculture to improve targeting of the poor. Aquaculture 492: 280–289.

Genschick, S.; Kaminski, A.M.; Kefi, A.S. & Cole S.M. (2017). Aquaculture in Zambia: An overview and evaluation of the sector's responsiveness to the needs of the poor. Penang, Malaysia: CGIAR Research.

Goppers K. & Miller J. (1989). Fish farming for rural development. An evaluation of SIDA/FAO supported aquaculture in southern Africa.

GRZ/ UNDP (2010). PIMS No. 3942; Adaptation to the effects of drought and climate change in Agro-ecological Regions I and II in Zambia.

IBRD/ The World Bank (2006). Aquaculture: Changing the Face of the Waters Meeting the Promise and Challenge of Sustainable Aquaculture. In Press: http://siteresources.worldbank.org/INTARD/Resources/Aquaculture_ ESW _vGDP.pdf. Report No. 36622 – GLB.

Jain, S. (2007). An Empirical Economic Assessment of Impacts of Climate Change on Agriculture in Zambia. The World Bank Development Research Group. Sustainable Rural and Urban Development Team.

Kaminiski, A. M.; Genschick, S.; Kefi, A. S. & Kruijssen, F. (2018). "Commercialization and upgrading in the aquaculture value chain in Zambia." Aquaculture, 493: 355-364.

Kawarazuka, N. & Béné, C. (2011). The potential role of small fish species in improving ′ micronutrient deficiencies in developing countries: building evidence. *Public Health Nutrition* 14.

Kefi, A. S.; Kang'ombe, J.; Kassam, D. & Katongo, C. (2013). Optimal Dietary Plant Based Lipid on Growth of Oreochromis andersonii (Castelnau, 1861). Turkish Journal of Fisheries and Aquatic Sciences 13: 503 –508.DOI: 10.4194/1303-2712 v13_3_13.

Kruijssen, F.; Avadi, A.; Cole, S.; Mungule, C.M. & van Duijn, A. (2018b). Aquaculture value chain analysis in Zambia. Report for the European Commission, DG-DEVCO. Value Chain Analysis for Development Project (VCA4D CTR 2016/375-804).

Kumar, D. (1992). Fish culture in undrainable ponds. A manual for extension. FAO fisheries Technical Paper No. 325. Rome, FAO, 1992. 239p.

Longley, C.; Haraksingh Thilsted, S.; Beveridge, M.; Cole, S.; Banda Nyirenda, D.; Heck, S. & Hother, A.-L. (2014). The role of fish in the first 1,000 days in Zambia. IDS Special Collection, Institute of Development Studies, Brighton BN1 9RE, U.K.

Mofya-Mukuka, R. & Kabisa, M. (2017). Gender and Nutrition Measurement Tools: Evaluating their Appropriateness in the Context of Zambia. Working Paper No. 120. Indaba Agricultural Policy Research Institute (IAPRI).

Mudenda H. G. (2009). Assessment of National Aquaculture Policies and Programs in Zambia. SARNISSA 2009. http://www.sarnissa.org/tiki-download_file.php?fileId=282.

Mudenda, M. (2006). 'The challenges of customary land tenure in Zambia', paper presented at Shaping the Change XXIII FIG Congress, Munich, German.

Mudenda, S.; Mulenga, L. & Mubanga, M. (2005). Intensification and Commercialization of Aquaculture in ASP Areas.

Mussa, H.; Kaunda, E.; Chimatiro, S.; Banda, L.; Nankwenya, B. & Nyengere, J. (2017). Assessment of Informal Cross-Border Trade in the Southern Africa Region: A case of Malawi and Zambia. Journal of Agricultural Science and Technology B 7 358-366.

Musuka, CG. & Musonda FF. (2012). Current and future prosecpts of commercial fish farming in Zambia. *AACL Bioflux* 5(1):79–97.

Musuka, C.G. & Musonda, F.F. (2013). Contribution of small water bodies and smallholder aquaculture towards poverty alleviation and enhancing household food security in Zambia. *International Journal of Fisheries and Aquaculture* 5(11):295–302. http://www.academicjournals.org/journal/IJFA/article-full-text-pdf/6B1EA1842047.

Musumali, M.; Heck, S.; Husken, S. & Wishart, M. (2009). *Fisheries in Zambia: An Undervalued Contributor to Poverty Reduction.* World Bank Policy Brief 1913. Washington, DC: The WorldFish Center/The World Bank. https://www.worldfishcenter.org/content/fisheries-zambia-undervalued-contributor-poverty-reduction

NFDS Africa. (2014). Zambia fish consumption survey. Report/Rapport: SF-FAO/2014/xx. January/Janvier 2014. FAO-SmartFish Programme of the Indian Ocean Commission, Ebene, Mauritius. 53 pp.

NFDS Africa. (2016). Report of the Zambia Fisheries and Food Security Surveys.

Nsonga A. (2015). Status quo of Fish farming in the Northern Province of Zambia a case for Mbala and Luwingu districts. International Journal of Fisheries and Aquatic Studies 2015; 2(6):255-258.

Policy Brief No. (2011-07). The WorldFish Center, May 2011. Financing Smallholder Aquaculture Enterprises.

Program on Fish Agri-Food Systems and Lusaka, Zambia: Department of Fisheries (2017-08). Working Paper: FISH-2017-08.

Utsugi, K. & Mazingaliwa, K. (2002). Field Guide to Zambian Fishes, Planktons and Aquaculture. JICA.

6 Annexes

Annex 1: Summary of study objectives and methods

Study topic	Objective	Relevant stakeholder	Method
Fish farming statistics	Overview of current fish farming activities at district level in Eastern Province	Department of Fisheries	Key informant interviews with provincial and district fisheries officers
Fingerling supply and availability	Evaluation of the current status of government-run and private hatcheries within the context of fingerling production and distribution	Hatcheries / fish culture stations	Key informant interviews with hatchery managers *(Annex IV)*
Fish farming system (1): small-scale fish farming	Assessment of the current situation of small-scale aquaculture production systems and identify opportunities and challenges	1. Individual small-scale fish farmers 2. Fish farming groups / cooperatives	1. Semi-structured interviews with fish farmers according to digital questionnaire "fishfarmer2018MW" provided by GIZ 2. Focus group discussions according to template provided by GIZ
Fish farming system (2): small water bodies	Assessment of the characteristics and management of community-based "small water bodies"	Dam management committees governing small water bodies	Key informant interviews with village authorities/dam management committees
Fish availability & consumption	Analysis of the availability of fish products for rural and urban populations as well fish preferences and consumption	1. Consumers in rural and urban areas 2. Fish traders and sellers in rural and urban areas	*1.* Semi-structured interviews with consumers according to questionnaire "consumer2018MW" provided by GIZ 2. Semi-structured interviews with fish traders and sellers according to questionnaire "supplychainactor2018MW" provided by GIZ

Annex 2: Stakeholder mapping

Stakeholder	Area of activity	Contact
Department of Fisheries under the Ministry of Fisheries and Livestock Dr. Alexander Shula Kefi, Chief Aquaculture Officer Mr. Edgar Kabeke, Provincial Fisheries Officer / Eastern Province Ms. Simukoko, District Fisheries Officer / Petauke district Mr. Trigger Hambalangwe, District Fisheries Officer / Katete district Mr. Victor Kawaga, District Fisheries Officer / Sinda district Mr. Chilufya Chitambala, District Fisheries Officer / Lundazi district Ms. Recent Mulenga, District Fisheries Officer / Mambwe district	The main function of the Department of Fisheries is to oversee the implementation of national fisheries programmes in capture fisheries and aquaculture development. The department is also responsible for the enforcement and regulation of the Fisheries Act, cap 22 of 2011 of the laws of Zambia. It carries out research in fisheries and aquaculture, in order to achieve a sustainable fishing industry and economic benefits.	Project Coordinator Zambia Aquaculture Enterprise Development Project (ZAEDP) askefi@yahoo.com Tel: (+260) 979255620 (+260) 969426244 catherinekamangadof@yahoo.com Tel: (+260) 977108916 triggerhambalangwe@gmail.com Tel: (+260 975948953) kawavictor@gmail.com chilufyachitambala@yahoo.com Tel: (+260) 976041622 mulengarecentbanda@gmail.com Tel: (+260) 966573051 (+260) 953340776
WorldFish WorldFish Zambia Office Plot 18944 Lunbansenshi Close Olympia	Strengthen livelihoods and enhance food and nutrition security by improving fisheries and aquaculture. Research programmes:	Mr. Sloans Chimatiro Country director s.chimatiro@cgiar.org Tel: (+260) 967983086

Off Katima Mulilo Road, Lusaka Mail: P.O Box 51289 Ridgeway Lusaka https://www.worldfishcenter.org	- Resilient small-scale fisheries - Sustainable aquaculture - Value chains and nutrition Potential contribution: - research & development - establishment of networks - coordination of round table - evidence-based development advice	Ms. Silke Uhlenbrock Integrated expert up-scaling aquaculture innovations S.Uhlenbrock@cgiar.org Tel: (+260) 211 294065/ 108 (+260) 097 9056582
Aquaculture Development Organization of Zambia (ADAZ) No.20 Limbe Road, Northmead, Lusaka www.adazambia.org	ADAZ is an association representing the interests of various stakeholders across the aquaculture value chain. These include fish farmers at all levels fish feed and seed producers, processors, marketers, service providers, research and learning institutions, local and international partners and government agencies Potential contribution: training and extension service.	Mr. Adrian Piers tilapia@zambia.co.zm info@adazambia.org adazambia@gmail.com
Food and Agriculture Organization of the United Nations (FAO)	FAO's cooperation with Zambia focuses on four priorities that resulted from a wide consultation process: agricultural productivity, food availability, security and nutrition improvement; support to the agriculture sector by enabling policies and investments; improved management of natural resources (land, water, forests) at various levels; improved livelihood resilience of targeted, vulnerable communities.	George Okech FAO Representative in Zambia George.Okech@fao.org Geoffrey Chomba Assistant FAO Representative in Zambia Geoffrey.Chomba@fao.org

Peace Corps 71A Kabulonga Road P.O. Box 50707 Lusaka https://www.peacecorps.gov/zambia/	The Rural Aquaculture Promotion (RAP) Project supports Zambia's Department of Fisheries' strategy of improving livelihoods in rural communities through promoting aquaculture as an activity from which farmers earn income, supplement their nutrition, and improve food security. The purpose of the RAP project is to assist smallholder rural farmers to apply new and improved aquaculture practices that sustainably increase fish production, consumption, and incomes. Potential contribution: training and extension service. Currently, no Peace Corps volunteers are present in Eastern Province, but it is planned to have volunteers again from April 2019 in certain districts.	Mr. Brad Favor Country Director bfavor@peacecorps.gov Tel: (+260) 211 260 377
Indaba Agricultural Policy Research Institute (IAPRI) 26A Middleway Road Mail: PostNet Box 99 Kabulonga, Lusaka http://www.iapri.org.zm/	IAPRI's mandate is to utilise empirical evidence to advise and guide the Government of the Republic of Zambia and other stakeholders on agricultural investments and policies. The overarching goal of IAPRI's policy analysis and outreach efforts is to identify policies and investments in the agricultural sector that can effectively stimulate inclusive economic growth and poverty reduction.	Dr. Rhoda Mofya-Mukuka Senior Research Fellow and Capacity Building Coordinator rhoda.mukuka@iapri.org.zm Tel: (+260) 977 771 079/81

	Potential contribution: - research & development - research-based development advice	
Feed companies Aller Aqua / Yalelo		Mr. Lewis Ngwenya: ln@aller-aqua.co.zm (+260) 968 829 425 www.aller-aqua.co.zm
Novatek	Producing high quality compound fish feed for pond culture, as well as "feed" with low protein content to be used as pond fertiliser.	Nutritionist: nutritionist@novatek.co.zm Tel: (+260) 974779068 www.zambeefplc.com
Skretting	Potential contribution: - Feed supply - Extension and consultancy about proper feed and fertilisation management	Technical advice: (+260) 976258187 sales.zambia@skretting.com www.skretting.com
Tiger Feeds		Nutritional helpline: (+260) 977 771250 www.tigerfeeds.com
Olympic Milling		Mr. Clinton: +260 971778393
Farmfeeds Ltd.		+260 211 240314 /244111 Peter.farmfeed@gmail.com www.farmfeedzambia.com

Annex 3: Travel schedule

Date	Time	Stakeholder	Person
Sat 18 Aug	Afternoon	**Chipata** - rural and urban consumer preferences	Fish traders, sellers and consumers
Sun 19 Aug		Chipata - rural and urban consumer preferences	Fish traders, sellers and consumers
Mon 20 Aug	Morning Noon 15:00	DoF, **Chipata** Hatchery GIZ Chipata Office	Provincial Fisheries Officer (PFO): Mr Edgar Kabeke Hatchery manager: Mr. Khosa GIZ Chipata Manager: Ms. Ricarda Schwarz
Tue 21 Aug	Morning 15:00	Fish farmers Other fish famers	Malajajest fish farmers cooperative
Wed 22 Aug	Morning, 9 am Noon Afternoon	DoF, **Petauke** Small water body (SWB), Kaulu dam SWB governed by traditional chief (Lusowe)	District Fisheries Officer, Ms. Catherine Simukoko Dam management Committee Dam management committee
Thu 23 Aug	All day	Fish farmers	Rural and peri-urban farmers in Petauke
Fri 24 Aug	Morning Afternoon	**Sinda** district Nyanje hatchery, Sinda Fish farms **Katete** district Chilingondi nursery ponds Kamphambe hatchery (*not in operation*) and fish farmers	Sinda DoF Officer: Mr. Victor Kawaga Two fish farmers Katete DOF officer: Mr. Trigger Hambalangwe
Sat 25 Aug	Data entry		In team in Chipata

Date	Time	Stakeholder	Person
Sun 26 Aug	Rest day in Chipata		
Week 2 Mon 27 Aug	Noon Afternoon	DoF **Lundazi** Private hatchery: Mphanga Yalala Enterprise Peri-urban fish farmer	DoF District Officer: Mr. Chilufya Chitambla Hatchery manager: Mr. Victor Banda
Tue 28 Aug	Morning Afternoon	Small water body Fish Farmer cooperative Fish farming Chanyondo Soy farmer	Tigone dam fisheries co-management cooperative Cooperative members Individual fish farmer
Wed 29 Aug	Morning Afternoon	Fish farmers Lundazi local market	 Fish traders and sellers
Thu 30 Aug	Morning Afternoon	Small water body (Chipata district): Mapala dam DOF **Mambwe** SWB: Chikowa dam project	Agriculture extension officer: Mr. Lackson Chookole DFO: Ms. Recent Mulenga
Fri 31 Aug	All day	In team in Mfuwe	
Sat 01 Sept	Rest day		
Sun 02 Sep	Afternoon		Travel back to Lusaka

Annex 4: Guiding questions for key informant interviews with hatcheries

- What fish species are produced in the hatchery?

- What is the current capacity (number of fingerlings produced) per species per year?

- What is the theoretical production capacity?

- How big is the demand (number of fingerlings sold) per species per year?

- Who do you supply with your fingerlings, *i.e.* who are your customers?

- If the demand is greater than the capacity, what is the reason that not more fingerlings can be produced?

- Which difficulties do you encounter during fingerling production (technical, financial, disease *etc*.)?

Annex 5: Fish availability in Eastern province: local market and store check

1. Shoprite supermarket Chipata

Product	Category	Company	Price per kg (ZMK)
Frozen			
Buka Buka	Whole round	Capital fisheries	55.00
Wild Tilapia bream	Whole round	Capital Fisheries	39.00
Tilapia, small	Whole round	Capital fisheries	34.00
Tilapia, medium	Whole round	Capital Fisheries	39.00
Tilapia, medium	Gutted, scaled	Capital fisheries	43.00
Tilapia	Fillet	Capital Fisheries	53.00
Nile perch	Fillet	Capital fisheries	75.00
Horse mackerel	Whole round	Capital Fisheries	40.00
Nchenga	Whole round	Capital fisheries	45.00
King Kapenta	Whole round	Capital Fisheries	47.50
Kapenta	Whole round	Capital Fisheries	47.50
Dried			
Kapenta	Whole round	Capital Fisheries	47.50

2. Yalelo outlet store

Product	Category	Price per kg (ZMK)
Tilapia (fresh or frozen)	Whole round	25.50

3. Dried fish at local markets

The main species sold at the main Lundazi market

Common name	Scientific name	Origin	Price/kgs
Mlamba (Cat fish)	*Clarias gariepinus*	Luangwa/Zambezi	30.00
Squeaker	*Synodontis nigromaculatus*	Meru/Bangweulu/ Zambezi	25.00
Churchill	*Petrocephalus catostoma*	Lake Malawi	30.00
Cichlids	*Oreochromis macrochir*	Luangwa	60.00
Cichlids	*Tilapia rendalli*	Luangwa	60.00
Tiger fish	*Hydrocynus vittatus*	Zambezi/Kariba	60.00
Labeo	*Labeo altivelis*	Lake Malawi/ Zambezi	60.00
Alestes	Alestes lateralis	Lake Malawi/ Tanzania	30.00
Kapenta	Strothrissa tanganicae	Lake Tanganyika	50.00
Kapenta	Limnothrissa miodon	Kariba dam	50.00
Burbus	Labeo burbus	Lake Malawi/ Tanzania	30.00

4. One retail store offering frozen fish

Product	Category	Price per kg (ZMK)
Tilapia (Tilapia Niloticus)	Medium size	28.00
Namibian Horse mackerel (Trachurus capensis)	Small size	40.00
Buka Buka (*Lates Stapersii*)	Medium size	50.00